

25UCET413	ADVANCED MECHANICS OF SOLIDS	Category	L	T	P	R	Credit	Year of Introduction
		PCC	3	0	0	0	3	2025

Preamble: This course extends the principles of mechanics of solids to three-dimensional stress and strain analysis, emphasizing advanced concepts relevant to structural and mechanical behaviour of materials. It introduces mathematical formulations governing stress transformations, strain relationships, energy methods, and specialized problems involving curved beams and thick-walled cylinders.

Prerequisite: MOS205 Mechanics of Solids

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Determine stresses in three-dimensional stress systems using analytical and graphical methods	K3 Apply
CO2	Apply strain relationships and elastic energy concepts in deformable bodies	K3 Apply
CO3	Illustrate stress distribution in curved beams and thick-walled cylinders	K3 Apply
CO4	Describe the fundamental behaviour and fracture mechanism of composite materials	K2 Understand

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	-	-	-	-	-	-	3	2	-
CO2	3	3	1	1	-	-	-	-	-	-	-	3	2	-
CO3	3	3	2	1	-	-	-	-	-	-	-	3	2	-
CO4	3	2	2	-	-	-	-	-	-	-	-	2	3	1
Avg	3	2.75	1.5	1	-	-	-	-	-	-	-	2.75	2.25	1

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*			*	
CO2	*	*	*	*	*			*	
CO3	*	*	*	*	*			*	
CO4	*	*	*	*	*				

Wks Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
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Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	2.5 hrs

Continuous Internal Evaluation Pattern:

Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment : 15 marks

SYLLABUS

Module 1 (10 hrs)

Elementary concepts of elasticity. Stress components in three dimensions. Principal stresses and stress invariants. Mohr's circle for three-dimensional stress state. Octahedral stresses and pure shear conditions. Plane stress and plane strain conditions. Differential equations of equilibrium. Comparison of plane stress and plane strain problems.

Module 2 (11 hrs)

State of strain at a point. Principal strains and strain invariants. Plane strain relationships. Strain measurement concepts. Compatibility conditions. Energy principles in elastic bodies: Work done by forces. Elastic strain energy. Reciprocal relations. Theorem of virtual work.

Module 3 (11 hrs)

Flexural Members: Asymmetrical bending of beams. Shear centre concept. Bending of curved beams. Stress distribution in curved beams of common cross sections. Deflection of thick curved bars. Axisymmetric problems: Thick-walled cylinders under internal and external pressure. Compound cylinders. Shrink fit stresses.

Module 4 (10 hrs)

Introduction to composite materials. Lamina and laminate concepts. Micromechanics of fibre reinforced composites. Introduction to fracture mechanics: Modes of fracture. Fracture parameters. Concept of fracture toughness and evaluation.

Text Books:

1. Arthur P. Boresi & Richard J. Schmidt (2022). *Advanced Mechanics of Materials*. 6th Edition. John Wiley & Sons.
2. L. S. Srinath (2017). *Advanced Mechanics of Solids*. 3rd Edition. McGraw Hill Education.
3. Robert M. Jones (1998). *Mechanics of Composite Materials*. 2nd Edition. CRC Press.
4. T. L. Anderson (2017). *Fracture Mechanics: Fundamentals and Applications*. 4th Edition. CRC Press.
5. Mohammed Ameen (2008). *Computational Elasticity*. Narosa Publishing House.

Reference Books:

1. A. R. Ragab & S. E. Bayoumi (1999). *Engineering Solid Mechanics: Fundamentals and Applications*. CRC Press. 1999
2. Martin H. Sadd (2006). *Elasticity: Theory, Applications and Numerics*. Academic Press.
3. Egor P. Popov (2016). *Engineering Mechanics of Solids*. Pearson Education India.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	PECET411
Course Name	ADVANCED SOLID MECHANICS
Max. Marks: 60	Duration: 2.5 Hours

Part A*(Answer all questions. Each question carries 3 marks)*

Qn No.	Question	Marks	CO	BL
1	Explain the significance of principal stresses and stress invariants in three-dimensional stress analysis.	3	1	L2
2	Differentiate between plane stress and plane strain conditions with suitable engineering applications.	3	1	L2
3	Explain the concept of strain compatibility and its importance in elasticity problems.	3	2	L2
4	Describe the significance of elastic strain energy and reciprocal relations in deformable bodies.	3	2	L2
5	Explain the concept of shear centre and its importance in the design of structural sections.	3	3	L2
6	Discuss the variation of stress distribution in curved beams compared to straight beams.	3	3	L2
7	Explain the concepts of lamina and laminate in composite materials.	3	4	L2
8	Describe the different modes of fracture and the significance of fracture toughness.	3	4	L2

Part B*(Answer any one full question from each Module. Each carry 9 marks)***Module I**

Qn No.	Question	Marks	CO	BL
9	A point in an elastic body is subjected to stresses: $\sigma_x = 120 \text{ MPa}$, $\sigma_y = 80 \text{ MPa}$, $\sigma_z = 40 \text{ MPa}$ $\tau_{xy} = 80 \text{ MPa}$, $\tau_{yz} = 20 \text{ MPa}$, $\tau_{zx} = 10 \text{ MPa}$ Calculate the principal stresses and maximum shear stress.	9	1	L3

OR

10	A material element is subjected to: $\sigma_x = 100 \text{ MPa}$, $\sigma_y = 60 \text{ MPa}$, $\sigma_z = 40 \text{ MPa}$ Compute: (i) Principal stresses (ii) Principal planes (iii) Maximum shear stress using Mohr's circle.	9	1	L3
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Module II

Qn No.	Question	Marks	CO	BL
11	At a point in a deformable body, $\sigma_x = 60 \text{ N/mm}^2$, $\sigma_y = 20 \text{ N/mm}^2$, $\tau_{xy} = 90 \text{ N/mm}^2$ Calculate the principal strains and maximum shear strain.	9	2	L3
OR				
12	A steel bar of length 2 m and cross-sectional area 1000 mm ² is subjected to an axial load of 150 kN. Given E=200GPa, compute: (i) Strain energy stored in the bar (ii) Extension of the bar using the energy method.	9	2	L3
Module III				
Qn No.	Question	Marks	CO	BL
13	A thick cylinder has an internal diameter of 200 mm and external diameter of 400 mm. It is subjected to an internal pressure of 30 MPa. Calculate the radial and hoop stresses at the inner and outer surfaces.	9	3	L3
OR				
14. a	A curved beam of rectangular cross-section 80 mm × 120 mm has a mean radius of 300 mm and is subjected to a bending moment of 20 kN-m. Compute the stress distribution at the inner and outer fibres.	9	3	L3
Module IV				
Qn No.	Question	Marks	CO	BL
15	Explain the micromechanics of fibre-reinforced composites and discuss the influence of fibre and matrix properties on composite behaviour.	9	4	L2
OR				
16	Describe the modes of fracture and discuss the significance of fracture toughness in engineering materials.	9	4	L2
